IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:		Atty. Docket No.:	004770.81503
Juha Ylitalo et al.			
Serial No.:	09/586,561	Group Art Unit:	2634
Filed:	June 2, 2000	Examiner:	Williams, Lawrence B.
For:	CLOSED LOOP FEEDBACK SYSTEM FOR IMPROVED DOWN LINK PERFORMANCE	Confirmation No.:	7618

DECLARATION UNDER 37 C.F.R. § 1.131

Honorable Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

We, JUHA YLITALO and MARCOS KATZ, hereby declare[1] that:

1) We are named as joint inventors of the above-captioned application, U.S. Application Serial No. 09/583,049, and all claims presently pending therein;
2) I, JUHA YLITALO, was formerly employed by Nokia Corporation (Nokia). Nokia is the assignee of the above-identified application.
3) I, MARCOS KATZ, was formerly employed by Nokia. Nokia is the assignee of the above-identified application.
4) We were employed by Nokia during development of the above-identified invention.
5) Prior to February 15, 2000, the publication date of Hottinen et al. (Transmit Diversity Using Filtered Feedback Weights in the FDD/WCDMA System, hereinafter *Hottinen*), we conceived of the invention recited in claims 1-8, 11, 15-17, 26-33, 36, and 40-42 of the above-captioned application, at least to the extent the claims are

[1] Each numbered declaration is a joint declaration unless an individual reference has been made. In such a case, the referenced individual or individuals are making the numbered declaration.

allegedly taught by *Hottinen*, and diligently pursued constructive reduction to practice in the form of a patent application filed with the United States Patent & Trademark Office.

6) Conception occurred prior to February 15, 2000, as is evidenced by the Report of Invention and comments to a draft specification attached in Exhibit A (dates redacted). The Report of Invention and comments to a draft specification were prepared prior to February 15, 2000.

7) Support for at least claims 1-8, 11, 15-17, 26-33, 36, and 40-42, of the above-captioned application can be found, among other places, at least within the Report of Invention and comments to a draft specification (Exhibit A) prepared prior to February 15, 2000.

8) Support for claims 1 & 26, can be found, among other places, on pages 1 and 2 and in Figure 1 of Exhibit A. Support for claims 2 & 27, can be found, among other places, on pages 1-4, and in Figure 1. Support for claims 3 & 28, can be found, among other places, on pages 1-3. Support for claims 4 & 29, can be found, among other places, on pages 1 and 2, in Figure 1, and in Table 1. Support for claims 5 & 30, can be found, among other places, on pages 2-4 and in Table 1. Support for claims 6 & 31, can be found, among other places, on page 1. Support for claims 7 & 32, can be found, among other places, on pages 1, 3, and 4. Support for claims 8 & 33, can be found, among other places, on pages 1, 2, and 4, and in Figure 1. Support for claims 11 & 36, can be found, among other places, on pages 1, 3-4, and in Figure 1. Support for claims 15 & 40, can be found, among other places, on pages 1-3, in Figure 1, and in Table 1. Support for claims 16 & 41, can be found, among other places, on pages 1-4. Support for claims 17 & 42, can be found, among other places, on pages 1-4.

9) Evidence of Diligence prior to the publication date of *Hottinen* (February 15, 2000) and the constructive reduction to practice (the filing date of June 2, 2000) of the present application can be found in Exhibits B-K.

10) On February 4, 2000, Mr. Timo Hussa of Nokia Networks sent a letter via facsimile to Mr. Daniel E. Fisher (the original drafting attorney of this application, formerly of

Banner & Witcoff, LTD.), discussing comments and revisions to the present application. A redacted copy of the first page of the letter is attached as Exhibit B.

11) On February 29, 2000, Mr. Fisher sent a letter via facsimile to Mr. Hussa, discussing revisions to the present application. A redacted copy of the first page of the letter is attached as Exhibit C.

12) On April 7, 2000, Mr. Fisher sent a letter via express courier to one of the inventors, Mr. Juha T. Ylitalo, discussing revisions to the present application. A redacted copy of the first page of the letter is attached as Exhibit D.

13) On April 18, 2000, Mr. Ylitalo sent a facsimile to Mr. Fisher commenting on the present application. A copy of the cover page of the facsimile is attached as Exhibit E.

14) On April 25, 2000, Mr. Fisher sent a letter via facsimile to one of the inventors, Mr. Ylitalo, asking the inventor questions about the present application. A redacted copy of the first page of the letter is attached as Exhibit F.

15) On April 26, 2000, Mr. Ylitalo sent a facsimile to Mr. Fisher clarifying issues with the present application. A copy of the cover page of the facsimile is attached as Exhibit G.

16) On April 28, 2000, Mr. Ylitalo sent a facsimile to Mr. Fisher providing more comments to the present application. A copy of the cover page of the facsimile is attached as Exhibit H.

17) On May 2, 2000, Mr. Fisher sent a letter via express courier to one of the inventors, Mr. Ylitalo, asking the inventor additional questions about the present application. A redacted copy of the first page of the letter is attached as Exhibit I.

18) On May 8, 2000, Mr. Ylitalo sent a facsimile letter to Mr. Fisher acknowledging receipt of a revised application draft and answering additional questions about the present application. A redacted copy of the first page of the facsimile letter is attached as Exhibit J.

19) On May 17, 2000, Mr. Fisher sent a letter via express courier to one of the inventors, Mr. Ylitalo, enclosing a revised draft application. A redacted copy of the first page of the letter is attached as Exhibit K.

20) On June 2, 2000, the present application was filed with the United States Patent and Trademark Office.

21) The exchange of draft applications with our patent attorney demonstrates diligence from before February 15, 2000 until the filing of the above-captioned patent application and the constructive reduction to practice of our invention.

22) All acts referred to in this Declaration were performed either in the United States, or in a WTO member country.

23) The attached Exhibit A has not been altered since it was originally prepared except for the redaction of references to dates on the document.

24) The attached Exhibits B-D, F, and I-K provide unaltered introductions to the first pages of documents that demonstrate diligent pursuit of a constructive reduction to practice. The remaining portions of Exhibits B-D, F, and I-K, including substantive comments, have been redacted.

25) The attached Exhibits E, G, and H have not been altered since they were originally prepared.

26) Each of us individually represent that we are over 18 years of age and of competent mind.

27) All statements made of our own knowledge are true and all statements made on information and belief are believed to be true; and further, these statements were made with the knowledge that willful, false statement so made are punishable by fine or imprisonment or both, under 18 U.S.C. § 1001 and that such willful, false statements may jeopardize the validity of the above-identified application or any patent issuing thereon.

Respectfully submitted,

Juha T. Ylitalo — Date: Oct. 8, 2004

Marcos Katz — Date:

20) On June 2, 2000, the present application was filed with the United States Patent and Trademark Office.

21) The exchange of draft applications with our patent attorney demonstrates diligence from before February 15, 2000 until the filing of the above-captioned patent application and the constructive reduction to practice of our invention.

22) All acts referred to in this Declaration were performed either in the United States, or in a WTO member country.

23) The attached Exhibit A has not been altered since it was originally prepared except for the redaction of references to dates on the document.

24) The attached Exhibits B-D, F, and I-K provide unaltered introductions to the first pages of documents that demonstrate diligent pursuit of a constructive reduction to practice. The remaining portions of Exhibits B-D, F, and I-K, including substantive comments, have been redacted.

25) The attached Exhibits E, G, and H have not been altered since they were originally prepared.

26) Each of us individually represent that we are over 18 years of age and of competent mind.

27) All statements made of our own knowledge are true and all statements made on information and belief are believed to be true; and further, these statements were made with the knowledge that willful, false statement so made are punishable by fine or imprisonment or both, under 18 U.S.C. § 1001 and that such willful, false statements may jeopardize the validity of the above-identified application or any patent issuing thereon.

Respectfully submitted,

Juha T. Ylitalo — Date

Marcos Katz — Date 30.9.2004

EXHIBIT A

Comments to Draft Specification and Patent Predisclosure Document

(Dates Redacted)

Comments to draft specifications (your ref. 4770.81503)

1 & 2. The assertion refers to the fact that the selection of beams is carried out by a) **the MS** in FDD systems, based on measurements done at the DL, or alternatively, b) by **the BS** in TDD systems, where UL and DL employ the same frequency. This is as a counterpart of what occurs if c) beam selection (or direction selection) in FDD is carried our by the MS, based on UL measurements. Since UL and DL use different frequencies (in FDD systems) any selection based on UL measurements will not necessarily be appropriate in DL (e.g., a direction with good response in UL may be in a deep fade when used in DL, due to the different frequencies). In a) and b) we can be sure that the selections are correct because they were done based on measurements using the actual DL frequency. In c) since UL and DL channels are uncorrelated in the short-term, there is no guarantee that the selection will be always correct.

The beam (or direction) selections made by the MS will tend to find the directions with favourable transmission conditions (e.g., low attenuation) towards MS. These directions may point directly to MS or ther may not, as in the case when signal from BS reaches the MS through reflections or scattering effects.

3. The selected beams may be adjacent or not. Contiguous beams define a common zone where the responses overlap. This common zone decreases very rapidly as angular separation of beams increases (e.g., non-adjacent selected beams). In order to exploit the diversity provided by two beams the MS must be able to separate (or resolve) the signals corresponding to each beam. In CDMA networks the Rake receiver at MS is able to separate signals received from different paths as long as they are separated in time (by the channel (delay spread) or by BS, by adding artificial delays) or/and code (by BS). In some cases some identifier (or signature) must be provided to the signals transmitted in each beam to facilitate the processing by the receiver. These could be a particular spreading code or pilot sequence used in each transmitted beam (codes are orthogonal to each other). The identifier is needed if downlink transmit diversity is employed: two signals are sent at the same time from different BS antennas but received with a SINGLE MS antenna --> the signals sum up at MS antenna; thus the MS must have some apriori reference by which it can can differentiate the two signals.

REPORT OF INVENTION

Invention name: An improved Tx-AA Downlink Diversity Scheme

Inventors: Marcos Katz and Juha Ylitalo NTC/RAS/WCDMA-Oulu.

Introduction and problem description

In one of the proposed closed loop transmit diversity scheme (Tx-AA modes of 3GPP) the Mobile Station (MS) estimates the downlink (DL) channel impulse responses from two Tx-antennas and uses this information to compute appropriate antenna weights for the two Base Station (BS) Tx-antennas. The Channel State Information (CSI) is transmitted depending on the particular mode using 1, 2, or 4 bits to the BS. In an ideal case, the exact values of CSI could be transmitted back to the BS and this would lead to optimum maximal ratio combining (MRC) at the transmitting side. However, this operation requires a large amount of bandwidth (extra UL overhead information) which will not be acceptable. In the currently proposed method (Tx-AA) few bits are reserved for this signalling purposes and hence only coarse CSI information is transmitted. In one mode of Tx-AA only phase information is transmitted (corresponding to coarse equal gain combining) while in another mode of Tx-AA both amplitude and phase angle information is fed back to the BS. The latter method corresponds to MRC and is optimal if interference can be modelled as AWGN.
The performance of the Tx-AA method greatly depends on the accuracy of CSI information. Tx-AA mode 4 achieves phase accuracy of 45° (3 bits) and amplitude accuracy of 1 bit (weight 0.2 or 0.8).
In low-mobility radio environments the channel (and CSI) is changing slowly compared to the feedback rate. In the present Tx-AA the same (rough) information about the channel is repeatedly transmitted to the BS in consecutive bursts. ***Instead, a method is proposed here in which the accuracy of the CSI information is improved recursively during the time period during which the channel has not changed significantly.***

Description of the proposed method:

In general, and to reduce the amount of information to be transmitted, one antenna is set as a reference with corresponding channel or weight coefficient $1+j0$ (or amplitude = 1, phase = 0°). Thus, with M transmitting antennas, only differential information to the remaining M-1 antennas is transmitted back to the base station. In particular, when $M = 2$ only one complex coefficient is required. In what follows the case for $M = 2$ is analyzed. Fig. 1 illustrates the principle of the segmented feedback method for a particular case where both phase (Pha) and amplitude (Amp) are segmented in four parts and $M = 2$. The process is described by the following operations: **1)** BTS transmits different pilots from each antenna; **2)** MS estimates the associated DL channels, computes the differential CSI and segments the Pha & Amp (or Re + j Im) information; **3)** MS transmits the segmented information in successive bursts; **4)** BTS receives and decodes (reconstructs) the segmented information.

A complex coefficient of the form Amp$\angle$Pha is to be transmitted by exploiting N consecutive slots. A partition of N is done in such a way that the first N_1 slots carry phase information and the remaining N_2 slots carry amplitude information. In principle N_1 and N_2 can be arbitrarily chosen, the only restriction being ($N = N_1 + N_2$). A common value for these parameters could be $N_1 = N_2 = N/2$. It is assumed that each slot has reserved K bits for conveying CSI information.
The phase can be resolved with an accuracy of

$$(\mathrm{Pha})_{min} = \frac{360}{2^{N_1 K}}\ [^\circ], \tag{1}$$

and the amplitude

$$(\mathrm{Amp})_{min} = \frac{A_{max}}{2^{N_2 K}}, \tag{2}$$

where A_{max} is the maximum amplitude.

Example 1
$N = 6, N_1 = N_2 = 3, K = 1$ (1bit/slot) and $A_{max} = 3$. The accuracy in the phase and amplitude are:

$(\mathrm{Pha})_{min} = 45^\circ$ and $(\mathrm{Amp})_{min} = 0{,}375$

Example 2
$N = 6, N_1 = N_2 = 3, K = 2$ (2bits/slot) and $A_{max} = 3$. The accuracy in the phase and amplitude are:

$(\mathrm{Pha})_{min} = 5{,}6^\circ$ and $(\mathrm{Amp})_{min} \cong 0{,}05$

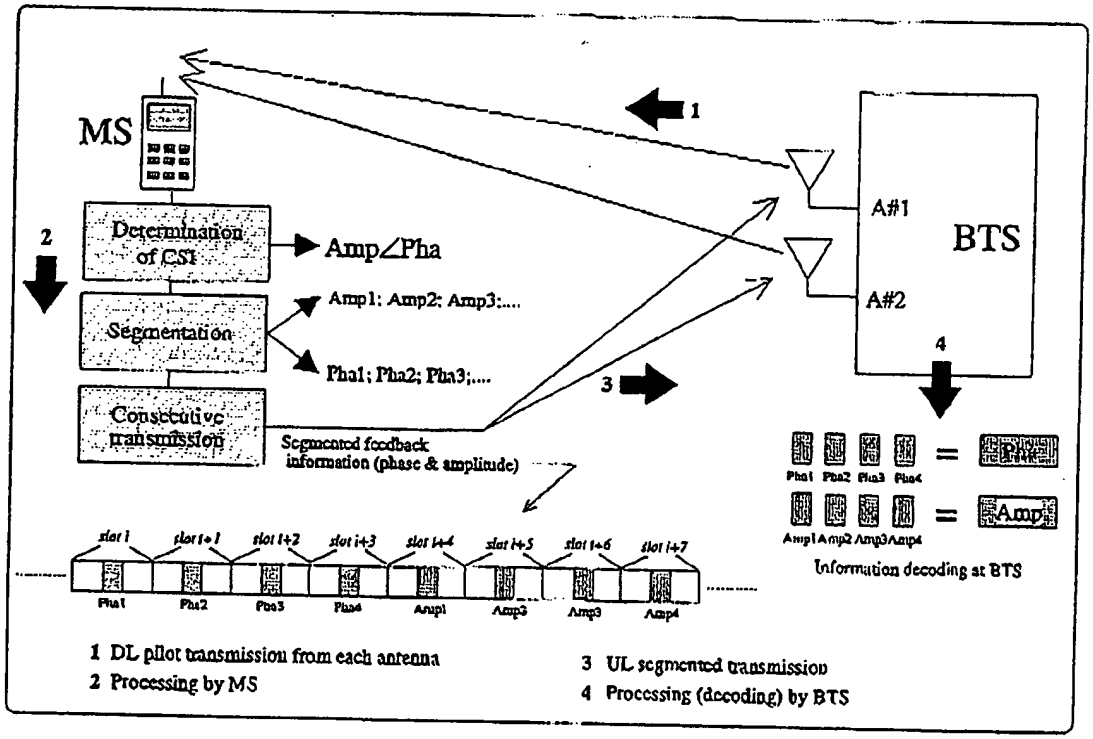

Figure 1. Principal description of the proposed segmented feedback method for improved downlink performance.

In general Pha$i$, $i = 1,2,\ldots, N_1$, (Amp$i$, $i = 1,2,\ldots, N_2$), contains partial information of the exact Pha (Amp) figure and it is transmitted in an hierarchical order. Thus, Most Significant Bits (MSB) are transmitted in first place and Least Significant Bits (LSB) in the last order.

Some analysis and an example

In the following an example is given which clarifies the proposed method. Assume that a MS is moving at a speed of v=1 m/s (3.6 km/h) and the carrier frequency is 2 GHz ($\lambda = 0.15$ m). Then the coherence time of the channel can be calculated as

$$T_c = 1/(2 f_D) = \lambda/(2 v) = 0.15 \text{ m}/ (2 \text{ m/s}) = 75 \text{ ms} \quad (3)$$

where f_D is the maximum Doppler frequency ($=v/\lambda$). It can be presumed that during $T_c/10$ the channel has not changed significantly and thus one could use 7.5 ms for transmitting the CSI information. Since in WCDMA the slot duration is 0.625 ms one could use 12 slots to feed back the CSI information. There are different possibilities in arranging the feedback. If only one bit/slot is allowed ($K = 1$) then one could send first a few slots with phase information and then a few slots with amplitude information as shown in Table 1:

Slot#	1	2	3	4	5	6	7	8	9	10	11	12
FB bit	Phase MSB	Phase MSB	Phase Bit 2	Phase Bit 2	Phase LSB	Phase LSB	Amp MSB	Amp MSB	Amp Bit 2	Amp Bit 2	Amp LSB	Amp LSB

Table 1. An example of using consecutive slots in feedback for improving recursively the accuracy of DL beamforming weights.

In Table 1 three-bit accuracy is used for both the phase angle and amplitude information. In the beginning the phase information is transmitted in a way that first the most significant bit is sent. Then the same bits is repeated (to improve reliability). After that the other phase angle bits and the amplitude bits are sent in a similar fashion. First bit gives the phase accuracy of 180° as in 1-bit mode of TX-AA and after 3 and 5 slots the phase accuracy becomes 90° and 45°, respectively.

Trade-off between the allowed feedback capacity (one or more bits/slot), the feedback reliability (# of repeated bits) and the feedback accuracy (# of phase angle and amplitude bits) has to be made.

If it is assumed that the phase angle changes approximately 360° during the coherence time of the channel then in the above example the phase angle change in 7.5 ms is about 36° . This corresponds well to the phase accuracy of 45° (3 bits).

In general, the phase angle information is more important (equal-gain combining performs only about 1 dB worse than MRC) and thus one could use more phase angle bits than amplitude bits. In principle, a phase error of $2\pi/8$ is acceptable /1/. Then one possibility could be to send 3 phase angle bits and 2 amplitude bits so that a minimum duration for feedback would be 5 slots (in WCDMA this corresponds to 3.125 ms).

Advantages/disadvantages and application areas

The proposed method improves the DL performance due to better phase angle and amplitude accuracy in DL beamforming (the method approaches MRC combining in DL). The method operates best in environments with

- Low mobility
- Low diversity (1-tap channel),

Therefore, the method suits best for high data rate applications in indoor and pedestrian environments. The proposed scheme is particularly appropriated to be used with high bit-rate wireless data applications for laptop computers.

Like any other feedback diversity modes the performance of the proposed method degrades in high mobility (vehicular) environments when the radio channel is changing rapidly.

Some other comments

It is pointed out that the proposed method can be employed in base stations exploiting either beamforming techniques (e.g. antenna array with interelement separation of $\lambda/2$) or antenna diversity (e.g., large antenna separation or antennas with different polarisation)

Note than in principle the proposed method can operate in two different fashions. BTS can either use the information as it is received and improve it gradually as new segments are received or, on the other hand, it can receive the whole segmented sequence to then effectively utilize the precise CSI.

References:

/1/ O. T. Von Ramm, "Beamsteering with linear arrays", IEEE Trans. BME, vol. 30, no. 8, 1983.

EXHIBIT B

Communications between Inventors/Assignee and Drafting Attorney
Demonstrating Diligence

(Comments Redacted)

DEF

RECEIVED

FEB 0 4 2000 mmo 2/4/00

BANNER & WITCOFF LTD.

NOKIA ***Fax***

NET/ RAS – BTS Development

Date: 04. February 2000
Pages: 2 + 28

From: Timo Hussa
Address: Nokia Networks, P.O. Box 319, FIN-90651 OULU, FINLAND
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Phone: +358 8 565 5397
E-mail: timo.hussa@nokia.com

REVIEWED

To: **Mr. Daniel E. Fisher**
Company: Banner & Witcoff Ltd
Fax: +1 202 508 9299
Your ref: 4770.81503
Our ref: NC 23282

Dear Mr. Fisher,

Referring to your letter dated 3rd of January 2000. I'm very sorry about the long delay.

In the application 23287 STTD (space time transmit diversity) mode is presented and how to adjust amplifiers of both antennas of BS (base station) based on power feedback information from MS (mobile station, remote station).

In the application 23282 STTD mode with complex feedback mode TxAA (Transmission Antenna Array) is presented.

EXHIBIT C

Communications between Inventors/Assignee and Drafting Attorney
Demonstrating Diligence

(Comments Redacted)

BANNER & WITCOFF, LTD.
INTELLECTUAL PROPERTY LAW

1001 G STREET, N.W.
WASHINGTON, D.C. 20001-4597

TEL: 202.508.9100
FAX: 202.508.9299
www.bannerwitcoff.com

February 29, 2000

Mr. Timo Hussa
Nokia Networks Oy
Kaapelitie 4
FIN-90630 OULU, FINLAND

VIA FACSIMILE

Re: **Closed Loop Feedback System**
For Improved Down Link Performance
Nokia Ref: NC 23282
Our Ref.: 4770.81503

Dear Timo:

Thank you for your February 4 facsimile letter providing instructions for revising this draft patent application, in response to our January 3 letter of inquiring about additional features that the inventors would like to add to the draft application. In accordance with your instructions, we will modify the application as follows.

EXHIBIT D

Communications between Inventors/Assignee and Drafting Attorney
Demonstrating Diligence

(Comments Redacted)

BANNER & WITCOFF, LTD.
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April 7, 2000

Mr. Juha T. Ylitalo
Nokia Telecommunications
P.O. Box 319
FIN-90651 OULU, FINLAND

VIA FEDERAL EXPRESS

Re: **Closed Loop Feedback System**
For Improved Down Link Performance
Nokia Ref: NC 23282
Our Ref.: 4770.81503

Dear Juha:

Thank you for your December 10 letter. Based on the information you provided in your letter and information provided by Mr. Hussa in his February 4 letter, we completely revised the claims and substantial aspects of the specification (i.e., the written description). We enclose a copy of the revised application for your review.

EXHIBIT E

Communications between Inventors/Assignee and Drafting Attorney
Demonstrating Diligence

NOKIA

Fax

DEF

Telecommunications

Date: Apr 18, 2000
Pages: 1+4

From: Juha Ylitalo
Address: P.O.Box 319 (Kaapelitie 4), 90651 Oulu, Finland
Fax: +358 8 565 5140
Phone: +358 8 565 5356
E-mail: Juha.T.Ylitalo@nokia.com

To: **Daniel E. Fisher**
Company: Banner & Witcoff, Ltd.
Fax: +1 202 508 9299
Cc to:
Your Ref. 4770,81503
Our Ref. NC 23282

Hi Dan,

Attached you find some comments.

Best regards,

Juha

--Juha & Marcos

EXHIBIT F

Communications between Inventors/Assignee and Drafting Attorney
Demonstrating Diligence

(Comments Redacted)

BANNER & WITCOFF, LTD.
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April 25, 2000

Mr. Juha T. Ylitalo
Nokia Networks Oy
P.O. Box 319
FIN-90651 OULU, FINLAND

VIA FACSIMILE

Re: **Closed Loop Feedback System**
For Improved Down Link Performance
Nokia Ref: NC 23282
Our Ref.: 4770.81503

Dear Juha:

Thank you for your April 18 facsimile letter. I have entered most of your suggested edits

EXHIBIT G

Communications between Inventors/Assignee and Drafting Attorney
Demonstrating Diligence

Fax DEF

NOKIA

Telecommunications

Date: Apr 26, 2000
Pages: 1+2

From: Juha Ylitalo
Address: P.O.Box 319 (Kaapelitie 4), 90651 Oulu, Finland
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Phone: +358 8 565 5356
E-mail: Juha.T.Ylitalo@nokia.com

To: **Daniel E. Fisher**
Company: Banner & Witcoff, Ltd.
Fax: +1 202 508 9299
Cc to:
Your Ref. 4770,81503
Our Ref. NC 23282

Hi Dan,

Attached you find some clarification. I fax this today even if I did not have yet enough time to study your comments thoroughly.

Best regards,

--Juha

REVIEWED

EXHIBIT H

Communications between Inventors/Assignee and Drafting Attorney
Demonstrating Diligence

NOKIA

Telecommunications

Fax

DEF

Date: Apr 28, 2000
Pages: 1+2

From: Juha Ylitalo
Address: P.O.Box 319 (Kaapelitie 4), 90651 Oulu, Finland
Fax: +358 8 565 5140
Phone: +358 8 565 5356
E-mail: Juha.T.Ylitalo@nokia.com

REVIEWED

RECEIVED

APR 2 8 2000

BANNER & WITCOFF LTD.

To: **Daniel E. Fisher**
Company: Banner & Witcoff, Ltd.
Fax: +1 202 508 9299
Cc to:
Your Ref. 4770,81503
Our Ref. NC 23282

Hi Dan,

Attached you find some more comments for clarification. Feel free to ask if there is something unclear.

Best regards,

--Juha

EXHIBIT I

Communications between Inventors/Assignee and Drafting Attorney
Demonstrating Diligence

(Comments Redacted)

BANNER & WITCOFF, LTD.
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1001 G STREET, N.W.
WASHINGTON, D.C. 20001-4597

TEL: 202.508.9100
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May 2, 2000

VIA FEDERAL EXPRESS

Mr. Juha T. Ylitalo
Nokia Networks Oy
P.O. Box 319
FIN-90651 OULU, FINLAND

Re: **Closed Loop Feedback System**
For Improved Down Link Performance
Nokia Ref.: NC 23282
Our Ref.: 4770.81503

Dear Juha:

Thank you for your April 26 and April 28 facsimile letters. I have revised the application as you requested and enclose a copy for your final review.

EXHIBIT J

Communications between Inventors/Assignee and Drafting Attorney
Demonstrating Diligence

(Comments Redacted)

NOKIA

Telecommunications

Fax

Date: May 8, 2000
Pages: 1+1

From: Juha Ylitalo
Address: P.O.Box 319 (Kaapelitie 4), 90651 Oulu, Finland
Fax: +358 8 565 5140
Phone: +358 8 565 5356
E-mail: Juha.T.Ylitalo@nokia.com

To: **Daniel E. Fisher**
Company: Banner & Witcoff, Ltd.
Fax: +1 202 508 9299
Cc to:
Your Ref. 4770,81503
Our Ref. NC 23282

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MAY 0 8 2000
BANNER & WITCOFF LTD.

Dear Dan,

Thank you for the revised application (I got it only today). Here I try to answer to your questions:

EXHIBIT K

Communications between Inventors/Assignee and Drafting Attorney
Demonstrating Diligence

(Comments Redacted)

BANNER & WITCOFF, LTD.
INTELLECTUAL PROPERTY LAW

1001 G STREET, N.W.
WASHINGTON, D.C. 20001-4597

TEL: 202.508.9100
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May 17, 2000

Mr. Juha T. Ylitalo
Nokia Networks Oy
P.O. Box 319
FIN-90651 OULU, FINLAND

VIA FEDERAL EXPRESS

Re: **Closed Loop Feedback System**
For Improved Down Link Performance
Nokia Ref.: NC 23282
Our Ref.: 4770.81503

Dear Juha:

Thank you for your May 8 facsimile letter and your May 10 e-mail. I have enclosed a revised patent application